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FORECASTING SYSTEMS TECHNICAL NOTE NO.12

SUMMARY of TROPICAL CYCLONE ACTIVITY and FORECASTS in the 1997-8 SOUTHERN HEMISPHERE SEASON

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MARCH 1999

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1. INTRODUCTION

A summary of tropical cyclone activity in the southern hemisphere for the 1997-8 season is presented below together with an assessment of the performance of the global model in predicting the tracks of these tropical cyclones.

Tropical cyclones are experienced in the South Indian Ocean, tropical seas to the west, north and east of Australia and the western and central South Pacific Ocean. For the purpose of tropical cyclone verification the southern hemisphere is divided in to two basins; the South-West Indian (west of 90°E) and Australian (east of 90°E). Mean error statistics for each basin are presented together with a table of statistics for the whole southern hemisphere. The global model produces a 6-day forecast every 12 hours. Verification is performed at 24 hour intervals up to forecast time T+120.

The global model resolution at the start of the season was 1.25°x 0.83°x 19 levels. This is equivalent to a horizontal resolution of 139km x 93km at the equator. This was increased to 0.83°x 0.55°x 30 levels on 28th January 1998. This is equivalent to a horizontal resolution of 93km x 62km at the equator. The tropical cyclone verification scheme identifies the centre of a tropical cyclone in the model by locating a local maximum of relative vorticity at 850hPa. A surface fitting technique is used to locate the centre accurately.

The terms used in the statistics tables are explained below :-

Possibly verified - No. of forecasts fulfilling requirements 1, 2 & 4 below.
Detection Rate - Percentage of possibly verified forecasts which also fulfil requirement 3 below.
Mean DX - Mean of positional errors in the East-West direction.
Mean DY - Mean of positional errors in the North-South direction.
Mean AT - Mean of positional errors in the Along Track direction.
Mean CT - Mean of positional errors in the Cross Track direction.
Skill - Percentage skill of model against CLIPER.
Mean DPE - Mean of direct positional errors.
All errors are measured in kilometres except where indicated.

(*) 1. Observed maximum wind at least 31 knots at the verifying time.
2. Forecast tropical cyclone centre equatorwards of 45 degrees.
3. Forecast tropical cyclone centre relative vorticity above a critical limit for verification (0.55×10^{-4} per second prior to 28th January 1998 and 0.65×10^{-4} per second thereafter).
4. Observation within 6 hours of verifying time present for use in verification.

Forecast skill is defined as:-
(CLIPER DPE - Model DPE) / CLIPER DPE x 100%

Positive skill indicates the model forecast is better than CLIPER.
Negative skill indicates the CLIPER forecast is better than the model.

A diagrammatic explanation of other error statistics and their sign conventions can be found in Appendix A. Full details of the TC verification scheme can be found in nwp Gazette, Vol.1, No.2, December 1994.

Advisory positions from RSMCs La Réunion and Nadi, Fiji, Bureau of Meteorology, Australia and JTWC (formerly) Guam were used as verifying observations of storm location when track verification was carried out immediately after a storm had ended. Best track data from RSMCs La Réunion and Nadi, Fiji, Bureau of Meteorology, Australia and Met. Service, New Zealand have been obtained for this season's storms and the track forecasts verified again. Statistics for verification against best-track observations are presented in detail. Some statistics for verification against real-time observations are included for the purposes of a comparison. Some mean error statistics for last season are also included for the purposes of a comparison. Forecast tracks are only verified when a depression reaches tropical storm status.

2. TROPICAL CYCLONE ACTIVITY

	SWI	AUS	TOTAL
Total number active 1996-7	15 (15)	24 (24)	39 (39)
Total number active 1997-8	11 (9)	25 (24)	36 (33)

Basin name abbreviations:- SWI = South-West Indian (west of 90°E)
AUS = Australian (east of 90°E)

The number in brackets indicates the number of depressions which reached tropical storm status (maximum sustained wind above 33 knots).

3. SUMMARY OF ALL SOUTHERN HEMISPHERE STORMS

3.1 South-West Indian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	55	37	24	14	6	1
Detection Rate (%)	100	100	92	86	83	100
Mean DX	3	-143	-394	-602	-569	-426
Mean DY	13	35	9	98	271	-89
Mean AT	-6	-66	-175	-232	59	-385
Mean CT	-17	-81	-66	-239	-629	-201
Mean Skill (%)	****	26	27	46	****	****
1996-7 Skill (%)	****	-8	9	22	****	****
Mean DPE	79	215	464	694	848	435
1996-7 DPE *	84	217	351	458	559	606
RT DPE #	78	209	453	690	879	223

* DPE for all South-West Indian storms in 1996-7 season
\# DPE calculated using real time observations as opposed to best track.

Comments :
A plot of the observed tracks of all storms in this basin can be found in Fig. 1.

Tropical cyclone activity was lower this season than in 1996-7 and only a few T+96 and T+120 forecasts were verified. Only TC Anacelle lasted more than 5 days. Forecast errors at T+48 to T+96 were larger than last season, but skill scores were significantly higher. Forecasts showed a right-of-track and slow bias overall. Figs. 2 and 3 show forecast errors and skill scores for the last few seasons. Skill scores were the highest ever achieved. T+24 forecasts showed skill over CLIPER for the first time.

3.2 Australian Basin Storms

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	239	188	145	111	85	63
Detection Rate (%)	100	100	97	91	86	83
Mean DX	1	-35	-116	-188	-151	-44
Mean DY	14	35	61	67	38	94
Mean AT	-1	-41	-71	-152	-238	-344
Mean CT	4	-9	-57	-94	-88	-50
Mean Skill (%)	****	48	48	48	****	****
1996-7 Skill (%)	****	27	41	43	****	****
Mean DPE	66	175	305	437	525	654
1996-7 DPE *	73	200	319	461	592	703
RT DPE #	60	177	311	449	534	656

* DPE for all Australian storms in 1996-7 season

DPE calculated using real time observations as opposed to best track.

Comments :

A plot of the observed tracks of all storms in this basin can be found in Figs. 4 and 5.

Activity in the Australian basin as a whole was similar to last season. However, there were much fewer storms on the western (Indian Ocean) side and many more on the eastern (Pacific Ocean) side - particularly in the central Pacific. This is what would be expected in an El Niño year. Forecast errors were slightly lower than last season's values at all forecast times and were the lowest ever achieved. Skill scores were also the highest ever achieved. There was a slight slow and right-of-track bias in forecasts. Fig. 6 and 7 show forecast errors and skill scores for the last few seasons.

3.3 Combined Statistics for whole Southern Hemisphere

Table of Mean Error Statistics

	T+0	T+24	T+48	T+72	T+96	T+120
Possibly Verified	294	225	169	125	91	64
Detection Rate (%)	100	100	96	90	86	83
Mean DX	2	-53	-154	-232	-178	-51
Mean DY	13	35	54	70	53	90
Mean AT	-2	-45	-85	-161	-219	-345
Mean CT	0	-21	-58	-110	-123	-52
Mean Skill (%)	****	45	44	48	****	****
1996-7 Skill (%)	****	15	30	36	****	****
Mean DPE	68	182	327	465	546	649
1996-7 DPE *	77	206	330	460	581	673
RT DPE #	63	182	330	475	556	648

* DPE for all southern hemisphere storms in 1996-7 season

\# DPE calculated using real time observations as opposed to best track.

Comments :

Figs. 8 and 9 show forecast errors and skill scores and Figs. 10 and 11 along-track and cross-track errors over the last few seasons.

Forecast errors were near to, or lower than last season's values. Skill scores against CLIPER were 12-30% higher than last season. Cross track errors were similar to previous seasons, but along track errors showed a significant slow bias compared to last season which had a very small bias.

There was little difference between figures derived using real-time and best track data.

Further Tropical Cyclone Information

The Met. Office pages on the World Wide Web contain information on tropical cyclone forecasting at the Met. Office. Monthly bulletins of tropical cyclone activity and forecasts are held together with observed and forecast track information of recent storms, track prediction error statistics, lists of names, images, movies and photographs and details of advances made in tropical cyclone track prediction at the Met. Office.

The Met. Office web site is:- **http://www.met-office.gov.uk**
Tropical Cyclone information can be found under the section "Weather & Forecasting".

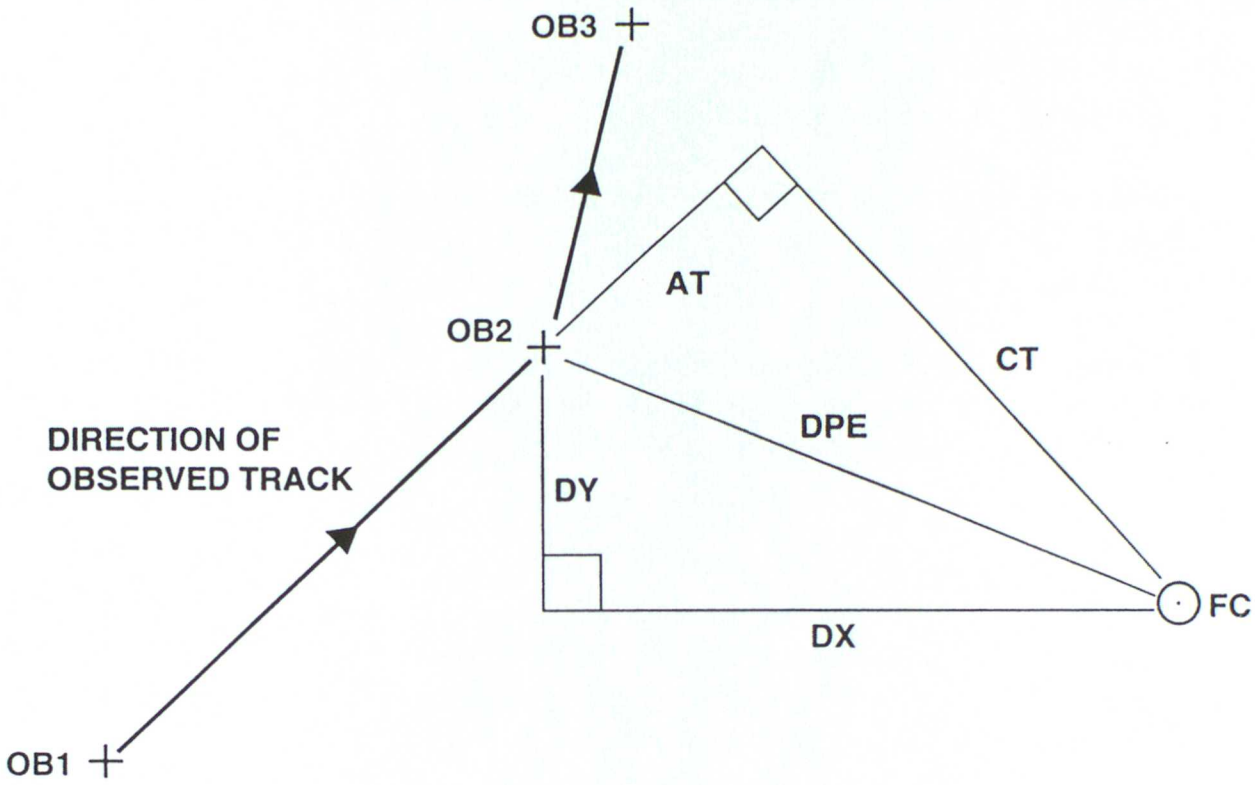
The information above is also available on ***Metnet*** under Julian Heming's home page. Contact Julian Heming (jheming@meto.gov.uk) for further information on tropical cyclone forecasting at the Met. Office.

Acknowledgements

CLIPER models for various basins were supplied by Mr.S.Lord, NMC, Washington, USA and Mr.C.Mauck, FNOC, Monterey, USA.
GrADS software used to produce track plotting charts was supplied by Mr.S.Lord and Dr.M.Fiorino.
Best track observations for the southern hemisphere were supplied by RSMC Météo-France, La Réunion, Bureau of Meteorology, Australia, RSMC Nadi, Fiji and Met. Service Ltd, New Zealand.

APPENDIX A

Diagrammatic Explanation of Forecast Errors



OB1-3 : Observed positions
FC : Forecast position verifying against observation OB2
DPE : Direct positional error
DX : Error in the East-West direction
DY : Error in the North-South direction
AT : Error in the Along Track direction
CT : Error in the Cross Track direction

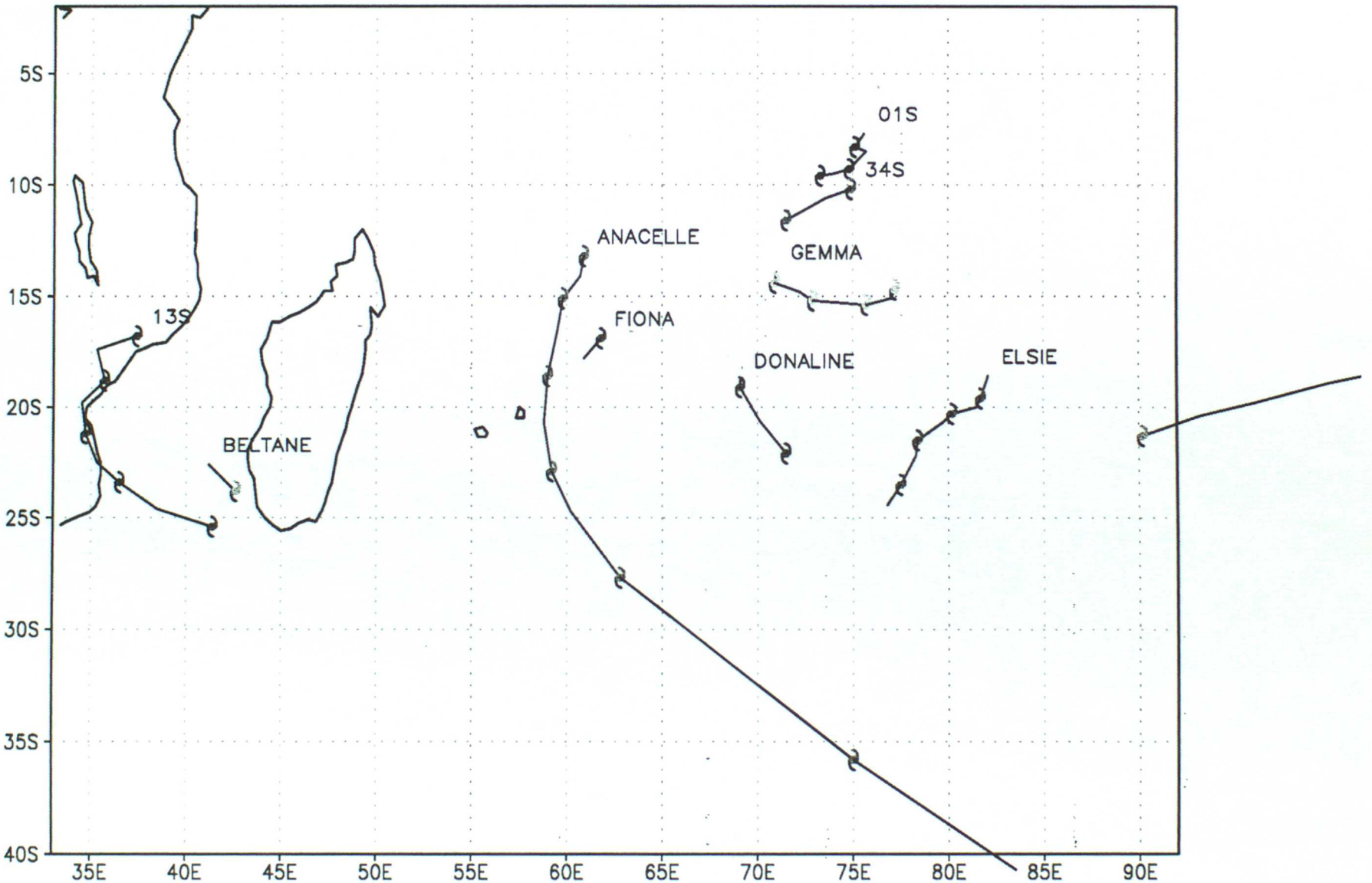
All errors are measured in kilometres

Sign Conventions

DPE values are always positive.
DX errors are positive if the forecast position lies eastwards of the observed position.
DY errors are positive if the forecast position lies polewards of the observed position.
AT errors are positive if the forecast position lies ahead of the observed position along the tropical cyclone track.
CT errors are positive if the forecast position lies right of the observed track in the northern hemisphere and left of the observed track in the southern hemisphere.

Figure 1

OBSERVED TRACKS of TROPICAL CYCLONES in the SOUTH–WEST INDIAN BASIN



01S 970722 13S 980118 ANACELLE 980209 BELTANE 980217 VICTOR 980211 DONALINE 980308
ELSIE 980313 FIONA 980317 GEMMA 980409 34S 980419

KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 00Z POSITIONS

Figure 2

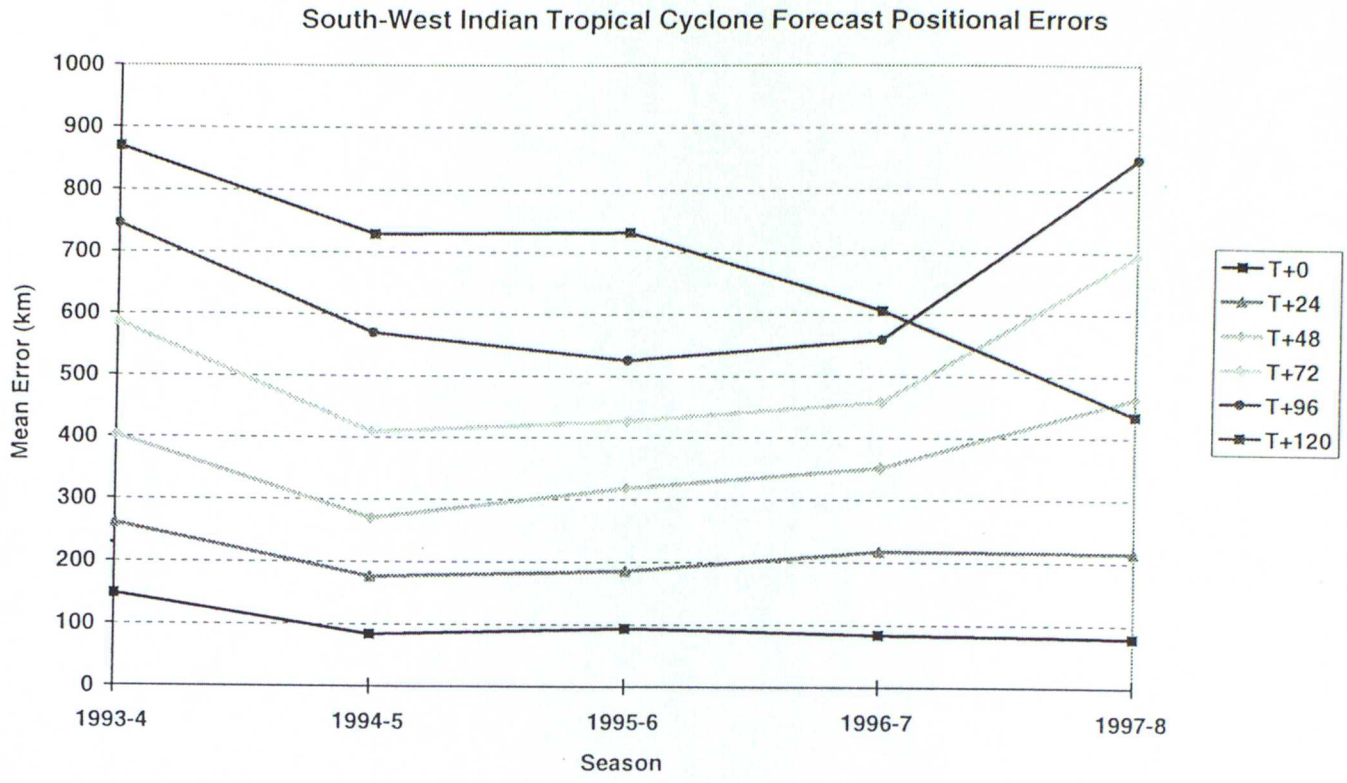


Figure 3

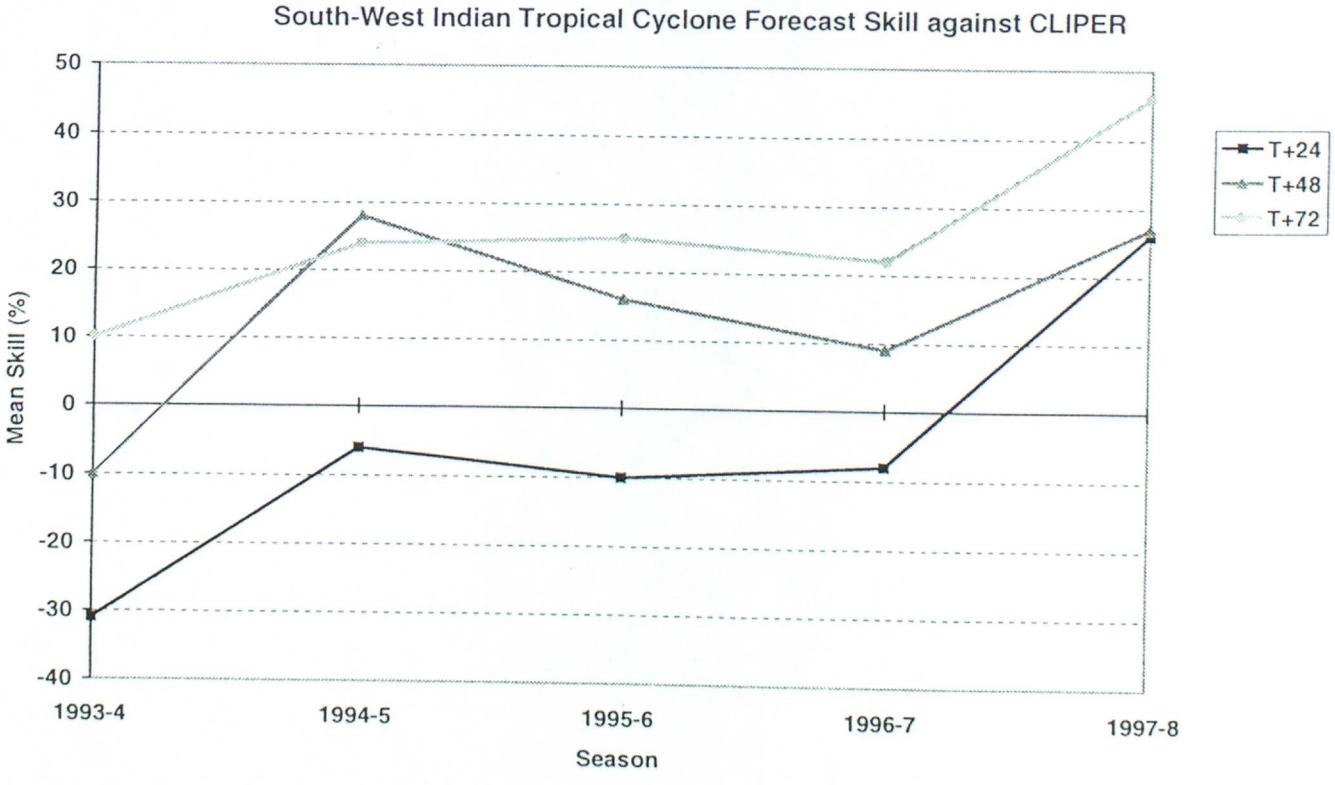
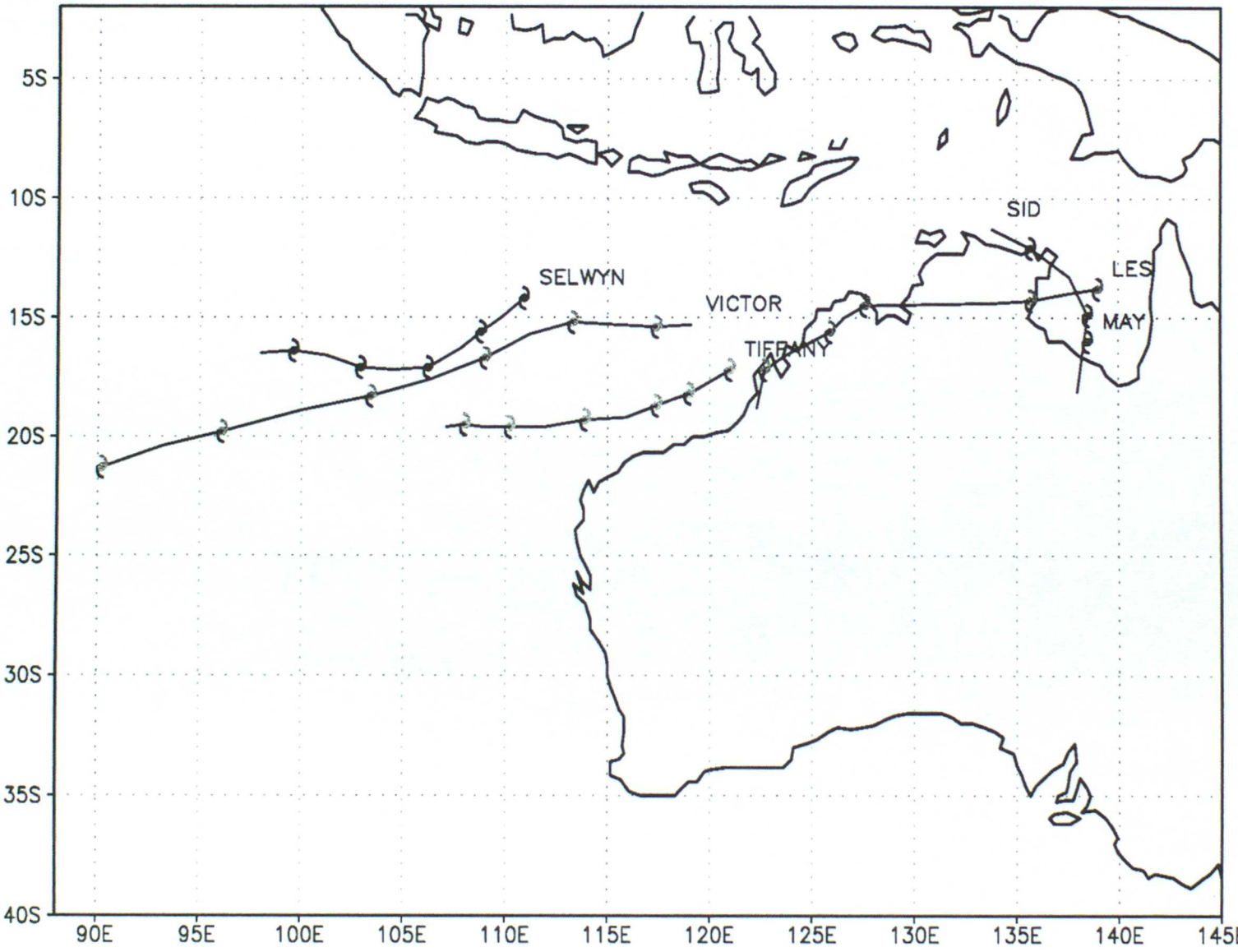


Figure 4

OBSERVED TRACKS of TROPICAL CYCLONES in the WESTERN AUSTRALIAN BASIN



SELWYN 971227 SID 971227 LES 980124 TIFFANY 980125 VICTOR 980211 MAY 980226

KEY to DATE of FIRST SYMBOL

24 HOURLY BEST TRACK OBSERVED POSITIONS

SYMBOLS REPRESENT 00Z POSITIONS

Figure 5

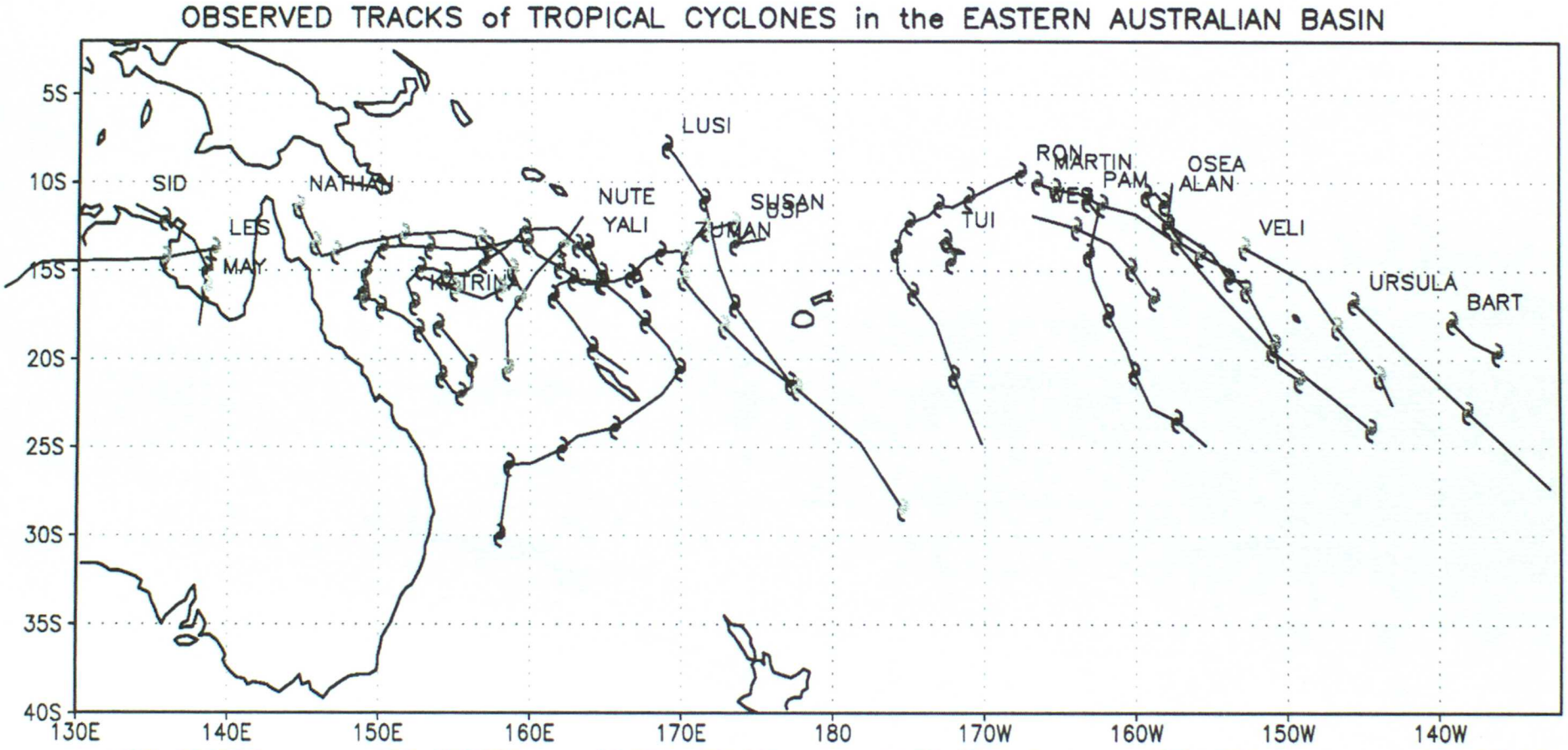

OBSERVED TRACKS of TROPICAL CYCLONES in the EASTERN AUSTRALIAN BASIN
5S
10S
15S
20S
25S
30S
35S
40S
130E
140E
150E
160E
170E
180
170W
160W
150W
140W
SID
NATHAN
LES
MAY
KATRINA
NUTE
YALI
LUSI
ZUMAN
SUSAN
03P
RON
MARTIN
WES
PAM
OSEA
ALAN
TUI
VELI
URSULA
BART
LUSI 971009
SID 971227
URSULA 980131
ZUMAN 980331
03P 971027
RON 980102
VELI 980201
ALAN 980422
MARTIN 971031
SUSAN 980103
WES 980202
BART 980430
NUTE 971119
KATRINA 980103
MAY 980226
OSEA 971124
LES 980124
YALI 980320
PAM 971206
TUI 980126
NATHAN 980322
KEY to DATE of FIRST SYMBOL
24 HOURLY BEST TRACK OBSERVED POSITIONS
SYMBOLS REPRESENT 00Z POSITIONS

Figure 6

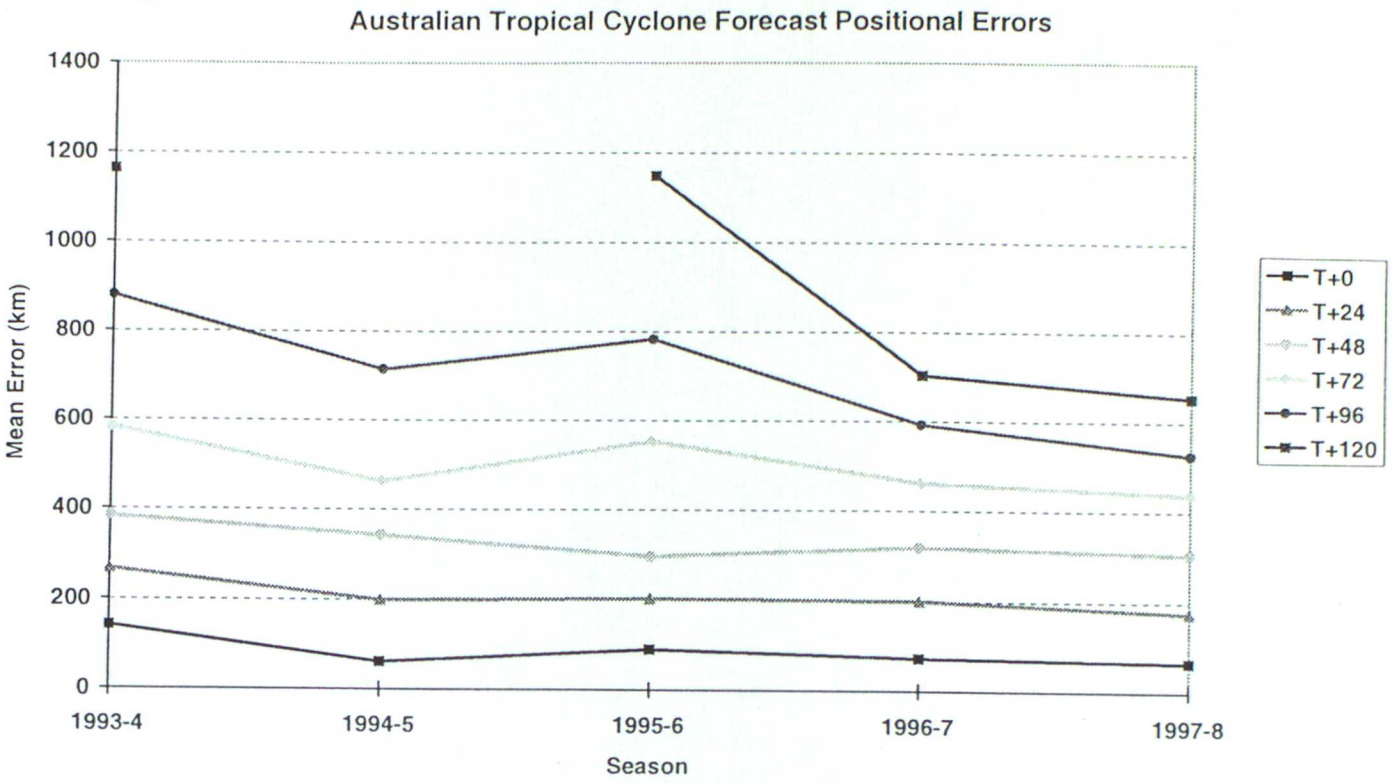


Figure 7

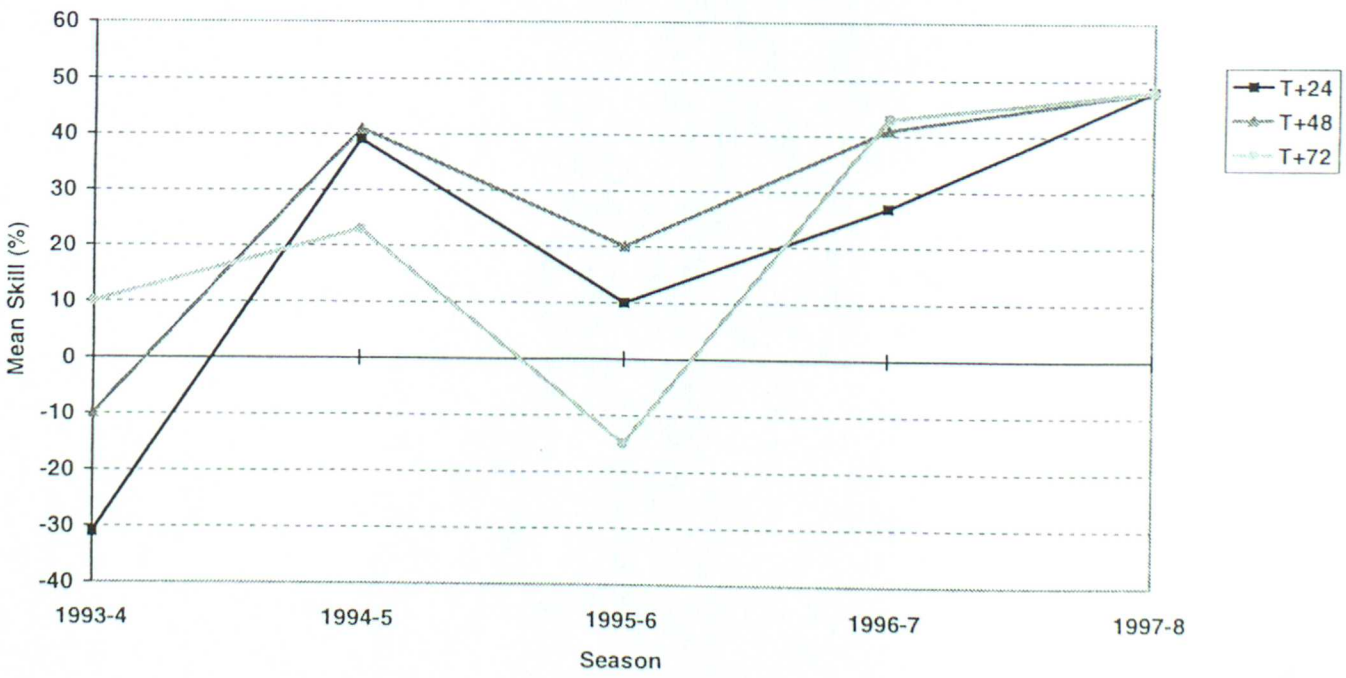


Figure 8

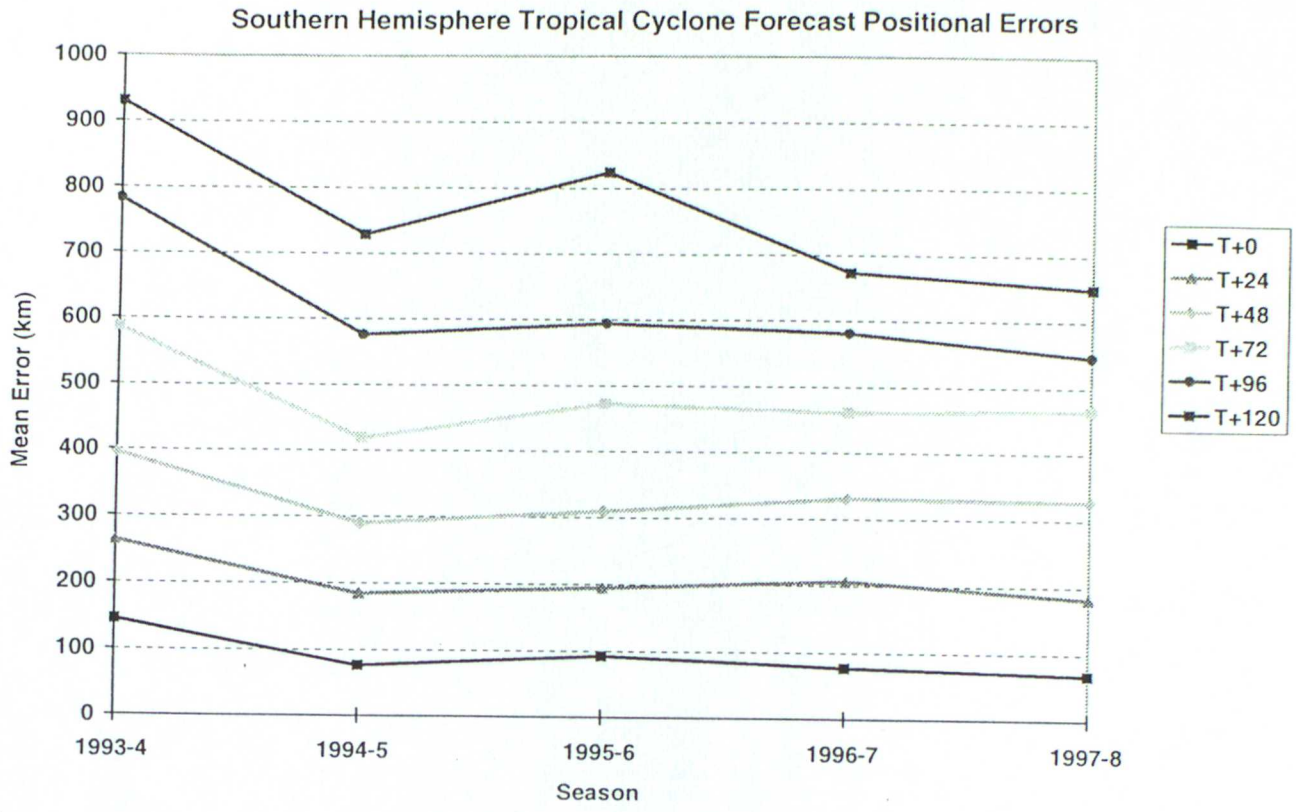


Figure 9

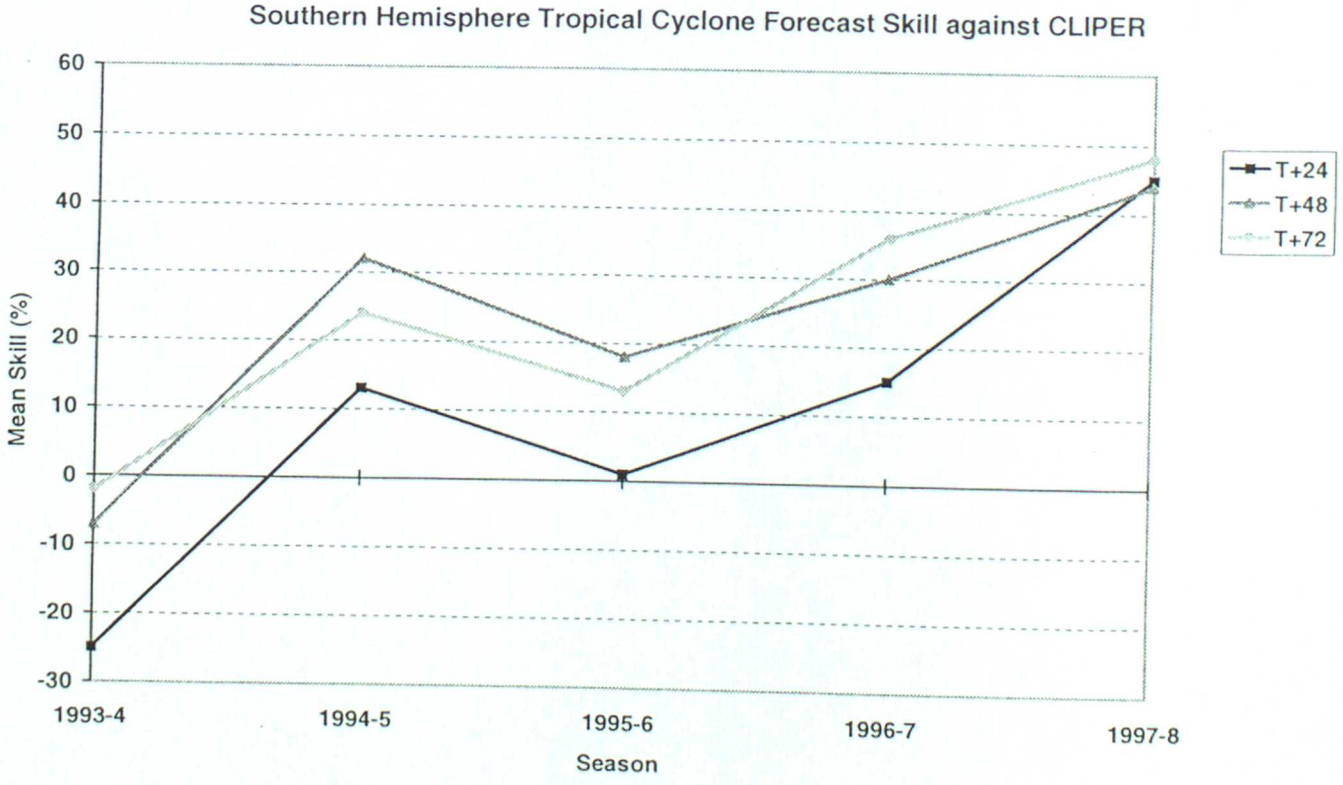


Figure 10

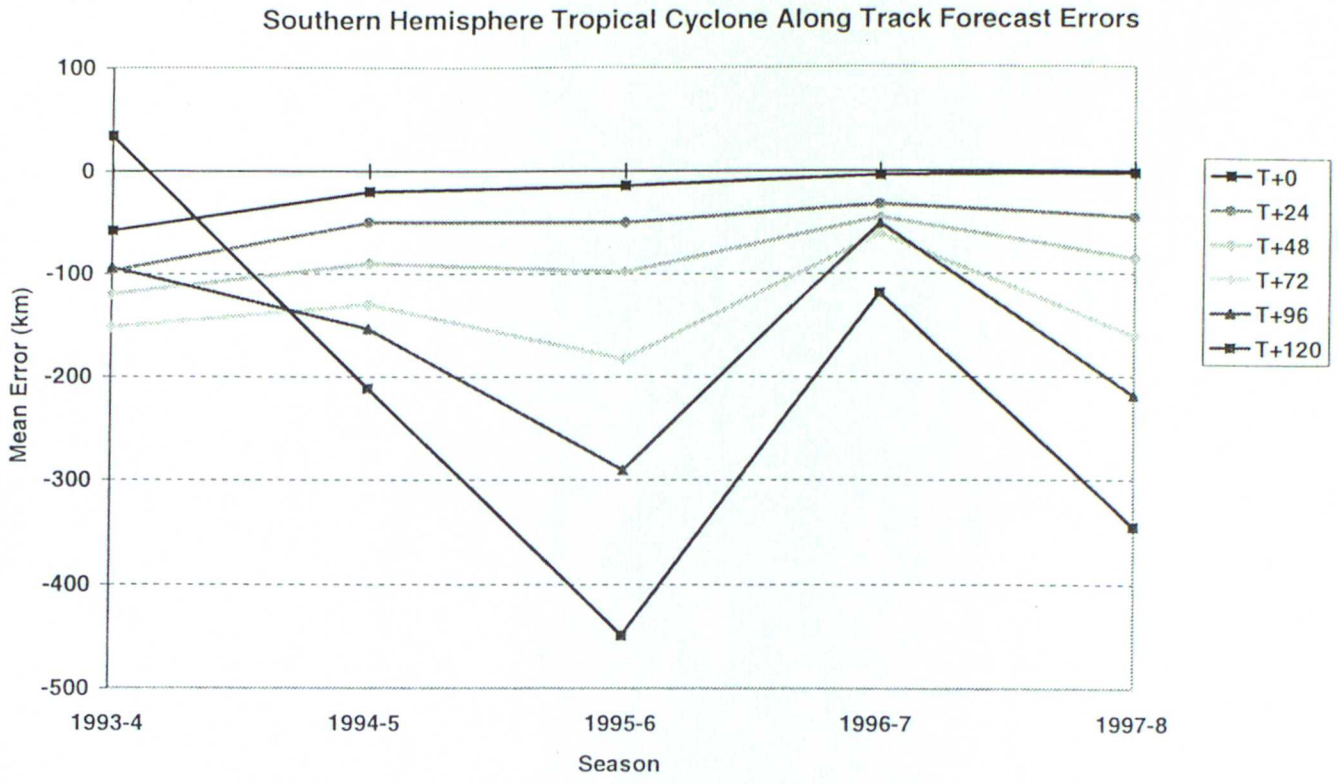


Figure 11